APPLICATION

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A heat exchanger device

TECHNICAL FIELD OF THE INVENTION

The present invention refers to a heat exchanger device including a plate heat exchanger, wherein the plate heat exchanger includes a plate package of heat transfer plates, which are arranged to form between the plates first passages for a heat transfer medium to be cooled and second passages for a cooling agent. The plate package includes a first porthole channel and a second porthole channel, which communicate with the first passages, and a third porthole channel and a fourth porthole channel, which communicate with the second passages. The first porthole channel forms at least a part of an inlet channel for supplying the heat transfer medium to the plate heat exchanger. The second porthole channel forms at least a part of an outlet channel for discharging the heat transfer medium from the plate heat exchanger. The third porthole channel forms at least a part of an inlet channel for supplying the cooling agent to the plate heat exchanger. The fourth porthole channel forms at least a part of an outlet channel for discharging the cooling agent from the plate heat exchanger. The heat exchanger device includes a conduit extending into the inlet channel for the cooling agent for supplying the cooling agent to the third porthole channel and the second passages.

THE BACKGROUND OF THE INVENTION

The plate heat exchanger in such a heat exchanger device may be an evaporator used for production of cold in various applications, such as air-conditioning plants, cooling in food stores, cooling in industrial processes, etc. In typical cases, a heat transfer medium in the form of a liquid, for instance water, is thereby to be cooled from a first temperature to a second. The temperature difference between the temperature of the outgoing

heat transfer medium and the temperature of the cooling agent is advantageously relatively small. It is important that the cooling agent in the evaporator, which provides the cooling of the heat transfer medium, is completely evaporated before it leaves the evaporator and is supplied to the compressor. If there are liquid droplets left in the cooling agent, these droplets will damage the compressor and reduce the efficiency and the lifetime of the compressor.

In order to avoid such liquid droplets in the cooling agent, it is known to superheat the cooling agent at the cooling agent outlet of the evaporator. For instance, it is known to provide such a superheating by means of the liquid to be cooled, i.e. the incoming liquid is firstly conveyed passing the outgoing cooling agent in order to raise the temperature of the cooling agent. One problem in this context is to have a sufficient temperature difference between the incoming liquid and the outgoing cooling agent. If this temperature difference is small, large heat transfer surfaces are required, which leads to a large evaporator.

On the other hand it is important the superheating is not going too far. If the cooling agent supplied to the compressor has a high temperature the required compressing work is large, which makes the cooling process energy-requiring.

PRIOR ART

EP-B-497 339 discloses a heat exchanger device having a plate heat exchanger used as evaporator in a cooling agent circuit. The plate heat exchanger includes a first plate part and a second plate part for the evaporation proper. In the first plate part the cooling agent to be supplied to the evaporator is conveyed in heat exchanging contact with the cooling agent leaving the evaporator. The expansion valve of the cooling agent circuit is provided upstream the first part for the incoming cooling agent. A further valve for the incoming cooling agent is provided downstream the first plate part.

US-A-5,678,419 discloses a similar heat exchanger device having a plate heat exchanger used as evaporator in a cooling agent circuit.

EP-A-1 083 395 discloses a cooling agent circuit including an evaporator, a compressor, a condenser and an expansion valve. The cooling agent leaving the condenser is conveyed in heat-exchanging contact with the cooling agent leaving the evaporator and supplied to the compressor.

DE-A-34 42 169 discloses a similar cooling agent circuit including an evaporator, a compressor, a condenser and an expansion valve. The cooling agent leaving the condenser is conveyed in heat exchanging contact with the cooling agent leaving the evaporator and supplied to the compressor.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a heat exchanger device with a plate heat exchanger to be used as an improved evaporator in a cooling agent circuit. A further object is to reduce the presence of liquid droplets in the cooling agent leaving the plate heat exchanger. A further object is to provide an evaporator having a high efficiency. The further object is to provide an evaporator having a large capacity in relation to the size of the evaporator. A further object is to provide a heat exchanger device that has a simple construction.

This object is achieved by the heat exchanger device initially defined, which is characterised in that said conduit includes a conduit portion extending into and out of the outlet channel for the cooling agent in such a way that heat exchange takes place between the cooling agent in said conduit portion and the cooling agent in the outlet channel.

The cooling agent is thus conveyed to its inlet channel and into the plate heat exchanger via the inventive conduit portion, which extends into and out of the outlet channel of the cooling agent. Consequently, the invention creates possibilities to raise the temperature of the cooling agent leaving the plate heat exchanger by means of the cooling agent located in the conduit portion. By means of the conduit portion according to the invention it is possible to prevent the cooling agent leaving the plate heat exchanger from containing liquid droplets. The cooling agent in the conduit portion may have a high temperature, for instance if the cooling agent located in the conduit portion arrives directly from a condenser of a cooling agent circuit. The possible liquid droplets which are too large or which have not yet been evaporated in the plate heat exchanger will be finely distributed, evaporated and superheated in contact with the conduit portion. Since the liquid droplets in the cooling agent thus may be minimised both in number and size, and the superheating is controlled, both the lifetime and the efficiency of the compressor are increased.

An evaporator formed by the heat exchanger device according to the invention has a higher capacity and/or efficiency than conventional evaporators. It is possible to achieve a smaller temperature difference between the cooling agent and the outgoing heat transfer medium than for conventional evaporators. In addition, the heat exchanger device according to the invention has a simple construction. The heat exchanger device according to the invention may be obtained by afterwards supplementing a plate heat exchanger by the conduit portion as defined.

According to an embodiment of the invention, the outlet channel for the cooling agent includes the fourth porthole channel and a pipe extending outwardly from the fourth porthole channel and the plate package, wherein said conduit portion extends at least into and out of said pipe. Advantageously, said conduit portion may also expand into and out of the fourth porthole channel.

According to a further embodiment of the invention, said conduit portion extends in a U-shaped path in the outlet channel. In order to increase the heat transfer to the cooling agent leaving the plate heat exchanger, said conduit portion may include surface enlarging members provided on the conduit portion and extending in the outlet channel. Such surface enlarging members may include flanges. Furthermore, it is possible to let said conduit portion extend in a path which is significantly longer than the double distance between an entrance position for the entrance of the conduit portion in the outlet channel and a position of the conduit portion located as far as possible away from the entrance position. For instance, said conduit portion may extend in a zigzag-shaped or helical-shaped path in the outlet channel.

According to a further embodiment of the invention, said conduit is included in a cooling agent circuit which includes a compressor, a condenser, and expansion valve and an evaporator that includes the plate heat exchanger. Said conduit portion is located between the condenser and the expansion valve.

According to a further of embodiment of the invention, the inlet and outlet channels are provided in such a way that the heat transfer medium flows through the first passages in a counterflow direction or parallel flow direction in relation to the cooling agent in the second passages.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now to be explained more closely through a description of various embodiments shown by way of example and with reference to the drawings attached hereto.

Fig. 1 discloses a functional diagram of a heat exchanger device according to the invention.

Fig 2 discloses schematically a front view of a plate heat exchanger of the heat exchanger device in Fig. 1.

Fig. 3 discloses schematically a side view of the plate heat exchanger in Fig. 2.

Fig. 4 discloses schematically a side view of an embodiment of a conduit portion of the heat exchanger device.

Fig. 5 discloses schematically a side view of another embodiment of a conduit portion of the exchanger device.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION.

Fig. 1 discloses a heat exchanger device including a cooling agent circuit with a compressor 1, a condenser 2, an expansion valve 3 and an evaporator 4. The evaporator 4 is designed as a plate heat exchanger to be described more closely below. A cooling agent is conveyed in a conduit 5 between the different components 1-4 in the cooling agent circuit. The conduit 5 includes a conduit portion 6, which is located between the outlet of the condenser 2 and the inlet of the expansion valve 3. The cooling agent in the conduit portion 6 is conveyed in heat exchanging contact with the cooling agent in the proximity and within the outlet of the evaporator 4.

Figs. 2 and 3 discloses a plate heat exchanger 10, which forms the evaporator 4 in the heat exchanger device in Fig. 1 the plate heat exchanger 10 includes a plate package 11 with heat exchanger plates 12 provided adjacent to each other. The plate package 11 is provided between two end plates 13 and 14. The end plates 13 and 14 are pressed against the plate package 11 and each other by means of tie-bolts 15 extending through the end plates 13 and 14. The tie-bolts 15 includes screw-threads and the plate package 11 may thus be compressed by nuts 16

threaded on to the tie-bolts 15 in a manner known per se. In the embodiment disclosed, four tie-bolts 15 are indicated. It is to be noted that the number of tie-bolts 15 may vary in different applications. Alternatively, the plates 12 together with the end plates 13 and 14 may be brazed to a plate package where the braze joints keep the plate package together and maintain the pressure.

The heat exchanger plates 12 are arranged in such a way that first passages 18 and second passages 19 are formed between the plates 12. The first passages 18 are intended to convey a heat transfer medium to be cooled and the second passages 19 are intended to convey a cooling agent. The plate package 11 includes a first porthole channel 21 and a second porthole channel 22, a third porthole channel 23 and a fourth porthole channel 24. The first porthole channel 21 and the second porthole channel 22 communicate with the first passages 18. The third porthole channel 23 and the fourth porthole channel 24 communicate with the second passages 19. The first porthole channel 21 forms at least a part of an inlet channel 31 for supplying the heat transfer medium to the plate heat exchanger 10. The second porthole channel 22 forms at least a part of an outlet channel 32 for discharging the heat transfer medium from the plate heat exchanger 10. The third porthole channel 23 forms at least a part of an inlet channel 33 for supplying the cooling agent to the plate heat exchanger 10. The fourth porthole channel 24 forms at least a part of an outlet channel 34 for discharging the cooling agent from the plate heat exchanger 10. In the embodiment disclosed in Figs. 2 and 3, the heat transfer medium will thus flow through the first passages 18 in a counterblow direction in relation to the cooling agent in the second passages 19. Alternatively, the heat exchanger device may designed in such a way that the heat transfer medium will flow through the first passages 18 in a parallel flow direction in relation to the cooling agent in the second passages 19.

As can be seen in especially Fig. 3, the conduit 5, with the conduit portion 6, extends, compare Fig. 1, in a path into and out of the outlet channel 34 for the cooling agent. The conduit 5 extends further to the conduit portion 6, compare Fig. 1, to the expansion valve 3. The conduit 5 extends from the expansion valve 3 into the inlet channel 33 for the cooling agent for supplying the cooling agent to the third porthole channel 23 and the second passages 19. Thanks to the conduit portion 6 in the outlet channel 34, a heat exchange will take place between the relatively warm cooling agent in the conduit portion 6 and the substantially evaporated, relatively cold cooling agent in the outlet channel 34.

As further can be seen clearly from Fig. 3, the outlet channel 34 for the cooling agent includes the fourth porthole channel 24 and a pipe 36 extending outwardly from the fourth porthole channel 34 and the plate package 11. In accordance with the embodiment disclosed herein, the conduit portion 6 extends in both the pipe 36 and the fourth porthole channel 24. It is to be noted that the conduit portion 6 also may extend merely in the pipe 36 but not in the porthole channel 24 proper. Furthermore, it is possible to dispense with the pipe 36 and thus let the conduit portion 6 merely extend into and out of the porthole channel 24 proper. In the embodiment disclosed herein, the outlet channel also includes a prolongation pipe 37 extending from the pipe 36. However, the conduit portion 6 connects to the pipe 36 in such a way that the conduit portion 6 does not extend in the prolongation pipe 37.

As can be seen from Fig. 3, the conduit portion 6 extends in a U-shaped path in the outlet channel 34 for the cooling agent. As can be seen from Fig. 4, the conduit portion 6 may advantageously but not necessarily include surface-enlarging members, for instance in the form of flanges 38, which are provided on the conduit portion 6 and extend substantially radially outwardly from the conduit portion 6. By such surface-enlarging members, the heat transfer from the cooling agent

from the condenser 2 to the cooling agent leaving the evaporator may be improved. According to an alternative embodiment illustrated in Fig. 5, the conduit portion 6 may extend in a path which is significantly longer than the double distance between an entrance position for the entrance of the conduit portion 6 in the outlet channel 34 and a position of the conduit portion 6 located as far as possible away from the entrance position in the outlet channel 34. As can be seen from Fig. 5, the conduit portion 6 may than extend in a reciprocating path, for instance a zigzag-shaped path in the outlet channel 34. Alternatively, the conduit portion 6 may extend in a helical-shaped path in the outlet channel 34. It is also possible to achieve such a surface-enlarging effect in other ways, for instance through embossing of the surface of the conduit portion 6.

The heat exchanger device also includes a sensor device 41 provided at or in the outlet channel 34 for the cooling agent. The sensor device 41 includes sensors for sensing the temperature and the pressure of the cooling agent discharged from the plate heat exchanger 10. In the embodiment disclosed in Figs. 2 and 3, the sensor device 41 is provided in the prolongation pipe 37, i.e. at a certain distance from the conduit portion 6. The sensor device 41 is connected to the expansion valve 3 for controlling the opening degree of the expansion valve 3 dependent on the pressure and the temperature of the outgoing cooling agent. The flow of the cooling agent into the evaporator 4 may thus be controlled via the expansion valve 3 which may include a pressure valve. The heat exchanger device according to the invention improves the stability of the superheating, which facilitates the control of the expansion valve 3 by means of the sensor device 41.

The invention is not limited to the embodiments disclosed but may be varied and modified within the scope of the following claim.